review masters

UPCAT Review

Compiled UPCAT Questions

Volume 10
Physics

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www.upcatreview.com

UPCAT Review – Volume 7 – General Science
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PREFACE

Believe That You Can Pass the UPCAT!
by Leopold Laset

Do you sometimes find it hard to believe that your dream to pass the UPCAT can become a reality? If so, then there is something very important that you need to know.

UPCAT is for dreamers like you.

Every student who passed the UPCAT began thinking or dreaming of passing the UPCAT.

Your near-perfect or perfect score in a quarterly test, your cellphone, PSP, or any gadget, your out-of-town (or out-of-country) vacation, your new pair of shoes, and any other stuff that you desired and now possess - are all the result of your 'dream come true'.

What this means is that throughout your lifetime, you have had an idea, you have desired for many things and worked hard for them, overcome problems and ultimately transformed your dream into reality.

And if hundreds and thousands of students have been able to pass the UPCAT in the past, by starting with a dream, then it stands to reason, that you can do it too.

Often we make the mistake of thinking that UPCAT is for a small number of bright students who have the brains and intelligence that we don't possess.

But this is simply not true.

The fact that thousands of average students have brought their dreams of passing the UPCAT to fruition in the past demonstrates that the opportunity to qualify in the UPCAT is something that is available to each UPCAT aspirant – average or bright.

Right now, hundreds of UPCAT dreamers are taking the steps necessary to achieve the goals of passing the UPCAT. Some are studying this early, some are joining community of fellow dreamers, and some are attending review classes. What is it that you need to do?

In order to achieve your goal of passing the UPCAT, the only things you really need are:

(1) A crystal clear picture that you already passed the UPCAT

(2) An unshakeable determination to do whatever it takes to make your dream of passing the UPCAT a reality

As soon as you take these two steps, passing the UPCAT becomes achievable. If you need a help – you look for it. If you encounter a difficult concept – you find a way to understand it. If you can't solve a math problem – you try and try and practice more.

And gradually, step-by-step, you bring your UPCAT dream into reality to join the dreams of the thousands of UPCAT dreamers who have gone before you.

So today I'd like to encourage you to believe in yourself and appreciate the fact that you live in a world where 'dreams do come true'.

Understand that thousands of students have made their UPCAT dream a reality in the past – Thousands more will make their UPCAT dream a reality in the near future and you CAN be one of them.

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- *INTRODUCTION TO VECTORS*
- *MOTION*
- *NEWTON'S LAW OF MOTION*
- *MOMENTUM AND IMPULSE*
- *WORK AND ENERGY*
- *UNIFORM CIRCULAR MOTION AND LAW OF UNIVERSAL GRAVITATION*
- *FLUIDS AT REST*
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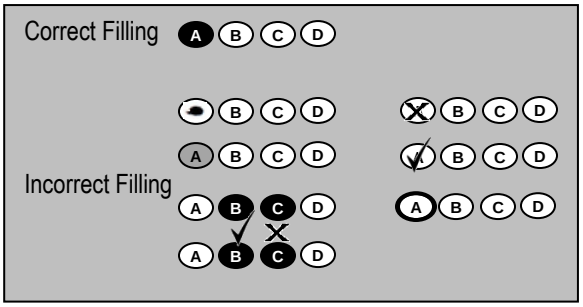

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PHYSICS REVIEW TEST

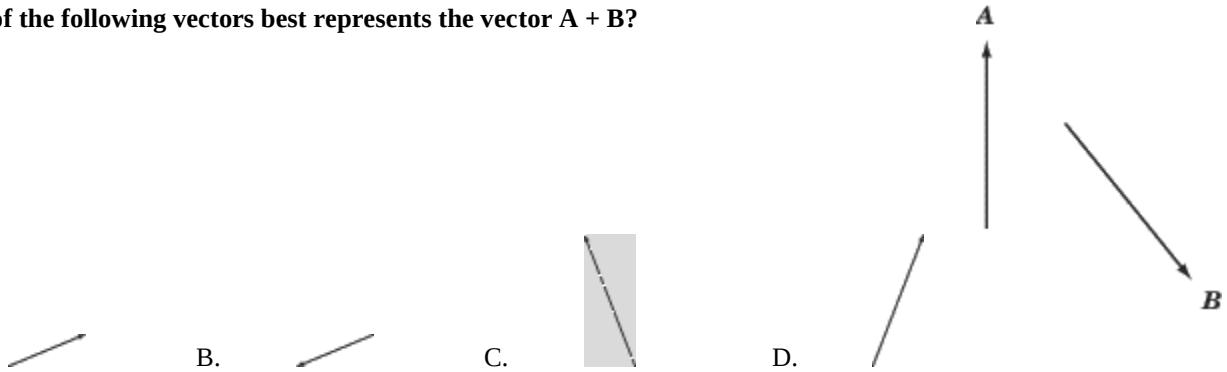
1. How many nm are there in an mm?

A. 10 B. 100 C. 1,000 D. 1,000,000

2. How many kW are there in a GW?

A. 10 B. 100 C. 1,000 D. 1,000,000

3. Which of the following vectors best represents the vector A + B?



A. B. C. D.

4. Vector A has a magnitude of 5 in the leftward direction and B has a magnitude of 2 in the rightward direction. What is the value of 2A – B?

A. 12 in the leftward direction
B. 10 in the leftward direction
C. 8 in the leftward direction
D. 8 in the rightward direction

5. Which among the following is a scalar quantity

A. Force B. Speed C. Displacement D. acceleration

6. Which of the following best describes a vector?

A. Has direction and time
B. Has direction and magnitude
C. Has magnitude and time
D. Has magnitude, direction and time

7. A car travels 5 km north turns right and travels for 2 hours at 6km/hr. How far is the car from it's original point

A. 11 km B. 12 km C. 13 km D. 17 km

8. An athlete runs four laps of a 400 m track. What is the athlete's total displacement?

A. –1600 m B. 400 m C. 0 m D. 1600 m

9. Which setting would give the fastest velocity if the original velocity is 6 m/s?

A. Running while there is no wind
B. running against the wind
C. running with the wind at your side
D. running when the wind is from behind you

10. Which of the following methods is used for vector addition?

A. Arithmetic method
B. Parallelogram method
C. Resultant method
D. Geometric method

11. To get the minimum value in adding vectors, the vectors should act

A. in the same direction
B. in opposite direction
C. at an acute angle
D. at a right angle

12. Can you add scalar quantities and vector quantities together

A. Yes
B. No
C. Yes if the magnitude is the same
D. None of the above

13. Which of the following does not describe an object in motion?

A. It has speed
B. It has direction
C. it has distance
D. it has velocity

14. The following situations exhibit acceleration EXCEPT

A. A rock falling to the ground.
B. A car decelerating to a stop.
C. A bus traveling at constant velocity
D. The blades of an electric fan spinning at constant speed.

15. What would happen to the velocity of a stone that is thrown downward?

A. It will increase.
B. It will decrease
C. It will change direction
D. It will remain constant.

16. A hunter sees a monkey sitting on a branch, and since the bow does not have a sight, the hunter pulls back the bow and points the arrow directly at the monkey. As the hunter releases the arrow the monkey notices the movement and drops off the branch. What happens next?

A. The arrow misses, passing above the monkey
B. The arrow hits the monkey
C. You need to know the distance to know what happens
D. You should not be killing animals

17. A bullet was shot horizontally in an open field, at the same time, it's shell fell to the ground. If they started from a height of 2 m, which will hit the ground first?

A. The shell
B. The bullet
C. They will at the same time
D. Needs more info

18. A sprinter starts from rest and accelerates at a steady rate for the first 50 m of a 100 m race. If the sprinter runs the 100 m in a time of 10 s, what is his average velocity when he crosses the finish line?

A. 5 m/s
B. 10 m/s
C. 12 m/s
D. 15 m/s

19. What is the acceleration of an object starting with a velocity of 3 m/s and increases to 31 m/s in 4 seconds?

A. $1 m/s^2$
B. $3 m/s^2$
C. $7 m/s^2$
D. $9 m/s^2$

20. At what angle should a ball be thrown to get the maximum linear distance?

A. 0°
B. 30°
C. 45°
D. 90°

21. What do you call an object launched into free space and acted upon by gravity alone?

A. object
B. particles
C. projectile
D. none of the above

22. How do magicians pull away table cloths from underneath plates leaving them on the table?

A. Because the plates have inertia
B. Because gravity pulls down on the plates.
C. Because porcelain plates have smooth surfaces reducing friction.
D. A magician never reveals their secret

23. A skydiver is traveling at terminal velocity, this means that?

A. He is in free fall
B. He is accelerating at $10 m/s^2$
C. His air resistance is equal to the acceleration to gravity
D. He needs to open his parachute

24. If an object is not accelerating then…

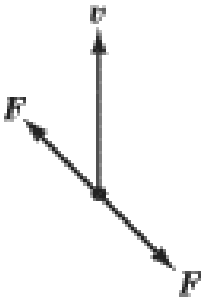
A. No forces are acting on it
B. It is in a state of equilibrium
C. It is not moving
D. Needs more information

25. Which of the following affects inertia the most?

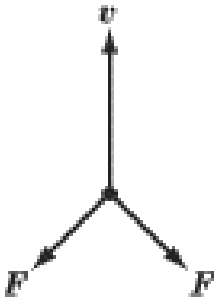
A. Velocity B. Acceleration C. Mass D. Volume

26. Each of the figures below shows a particle moving with velocity v, and with one or two forces of magnitude F acting upon it. In which of the figures will v remain constant?

A. 

B. 

C. 

D. 

27. A wooden block is given an initial velocity up an incline plane. The block slides up the incline plane to some height and then slides back down the incline to the bottom. There is friction between the block and the incline plane. Does it take the same time for the block to slide down the incline as it took to slide up the incline?

A. Yes, it's the same distance up and down, so the time up and down will be the same.
B. No, it takes more time to slide down the incline plane than it took to slide up.
C. No, it takes less time to slide down because gravity is helping the block slide down.
D. What exactly is an incline plane?

28. A crate resting on a floor is given a pull just enough to start it moving, which of the following best describes the situation?

A. A force of friction is acting on the crate.
B. Friction is equal to the applied pull.
C. Friction is greater than the applied pull.
D. The crate is accelerating since there is a presence of a force.

29. A person is standing on a weighing scale inside an elevator. When the elevator is at rest, the reading on the scale is 70 kg. What will be the new reading on the scale if the elevator is accelerating upward?

A. the reading on the scale will not change
B. it will be greater than 70 kg
C. the scale will give a reading lower than 70 kg.
D. The person will not be able to read the scale because of motion sickness.

30. Why is it harder to get an object in motion than to keep it in motion?

A. Static friction is greater than kinetic friction
B. Static friction is less than kinetic friction
C. An object in motion already has momentum
D. Mass decreases in motion thus reducing friction

31. Leopold and Jojo pull on opposite ends of a rope in a tug of war game. Who exerts the greatest force on rope if Jojo is winning?

A. Leopold B. Jojo C. Both the same D. Needs more information

32. What is the weight of a man whose mass is 80 kg?

A. 8.2 N B. 98 N C. 784 N D. 980 N

33. A cart is being accelerated by the pull of the horse. Which force makes the cart move forward?

A. The force of the horse on the cart
B. The force of the ground on the cart
C. The force of the horse on the ground
D. The force of the ground on the horse

34. Which of the following situation gives the largest momentum?

A. A truck parked in a parking lot
B. A massive boulder on top of a mountain.
C. A snail climbing a wall.
D. A big grocery store.

35. The situations enumerated below can increase your momentum EXCEPT

A. Increasing the speed of the object while maintaining its mass.
B. Increasing the mass of the object while maintaining its speed.
C. Increasing both the mass and the speed of the object.
D. Increasing the volume of the object while maintaining its mass and speed.

36. An airplane is flying with a constant speed in a straight path. Which of the following is NOT TRUE for the given situation?

A. The momentum of the airplane is constant
B. The airplane is a projectile that is acted upon by gravity alone
C. There is no net force acting on the airplane
D. The airplane is in equilibrium

37. An object of mass m moving with a velocity v collides with another object of mass M. If the two objects stick together, what is their velocity?

A. mv / (m + M) B. (m + M) / Mv C. mv / M D. Mv / (m + M)

38. An airbag save lives of people in car accidents by…

A. Reducing impulse in stopping
B. Increasing the time to stop
C. Both of these
D. none of these

39. If the boxer moves into the punch such as to decrease the duration of impact by half, how much will the force of impact be increased?

A. 2 times greater
B. 4 times greater
C. 8 times greater
D. the impact force will be the same

40. A man jumps into an air cushion while another jumps to concrete floor. Which of the following is true for the conditions stated?

A. The change in momentum is higher on the concrete floor
B. The impulse is less on the air cushion
C. The change of momentum is the same in both conditions
D. The time to stop is the same for both conditions

41. A truck and a bicycle had a head on collision. Which of the following statements is TRUE with regards to the change in momentum?

A. The change in momentum of the bicycle is greater than the truck
B. The truck experiences a greater change in momentum
C. Both the truck and the bicycle experienced the same change in momentum
D. Cannot be concluded since the data given are insufficient

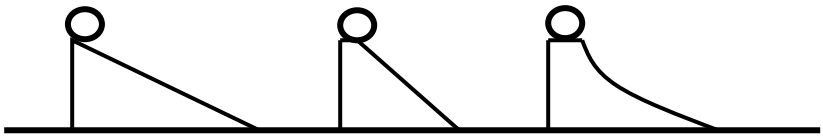
42. A sniper fires heavy bullet from a high-tech gun such that the bullet is heavier than the gun. What would happen in this instance?

A. The bullet will not fire
B. The bullet travels faster
C. The gun will have less recoil
D. It's safer to be the target than the sniper

43. Two 1 kg masses moving toward each other, one mass with velocity = 10 m/s, the other with velocity = 20 m/s. What is the velocity of the center of mass?

A. 5 m/s to the left
B. 10 m/s to the left
C. 15 m/s to the left
D. 20 m/s to the left

44. All the ramps are 5-meters high. If a ball is rolled along the ramp, which ball will reach the bottom first assuming the ramps have negligible friction?



A. Ball A B. Ball B C. Ball C D. They will hit at the same time

45. What happens to the potential energy as an object falls to the ground?

A. increases
B. lost
C. changed into kinetic energy
D. stored as potential energy

46. A person on the street wants to throw an 8 kg book up to a person leaning out of a window 5 m above street level. With what velocity must the person throw the book so that it reaches the person in the window?

A. 10 m/s B. 20 m/s C. 30 m/s D. 40 m/s

47. How much work is done on a 75-N bowling ball when you carry it to 3 m high?

A. 25 N/m B. 25 N-m C. 225 N/m D. 225 N-m

48. How much work does a person do in pushing a box with a force of 20 N over a distance of 8.0 m in the direction of the force?

A. 1.6 J B. 16 J C. 160 J D. 1600 J

49. If you push an object with twice the work input over the same length of time, your total power input is

A. four times as much
B. twice as much
C. remains the same
D. half its original

50. An object's velocity is doubled, what would happen to its kinetic energy?

A. four times as much
B. double
C. remains the same
D. none of these

51. Which pulley would require the least amount of force in pulling up a 10 kg object 1 meter high?

A. fixed B. movable C. block and tackle D. combination

52. How much work would be needed in the problem above?

A. 10 N B. 10 J C. 10 W D. depends on the pulley

53. If you push an object twice as far and applying twice the force you do

A. the same amount of work
B. twice as much work
C. four times as much work
D. none of these

54. What is the force of gravity on a 40 kg woman standing on the earth's surface?

A. 232 N B. 392 N C. 498 N D. 527 N

55. If the density of the earth somehow increased with no change in radius, your weight would

A. increase B. decrease C. stay the same D. all of the above

56. If the Earth were compressed in such a way that its mass remained the same, but the distance from the core to the equator were just one-half what it is now, what would be the acceleration due to gravity at the surface of the Earth?

A. g/2 B. g C. 2g D. 4g

57. Consider two planets in space that gravitationally attract each other. If the mass of planet A is twice the mass planet B then…

A. The pull of planet A on planet B is twice the pull of planet B on A
B. The pull of planet B on planet A is twice the pull of planet A on B
C. The pull of planet A on B is equal to the pull of planet B on A
D. The pull of planet A is four times the pull of planet B

58. Why are sharp curves on roads usually banked?

A. there might be an incoming vehicle
B. the centripetal force might decrease
C. banking would counter the centrifugal force
D. banking would counter the centripetal force

59. Stone A is tied to the end of a string, stone B is tied to a shorter string, if both stones were whirled so that they would complete one revolution at the same time, which stone will be traveling faster?

A. Stone A C. They will have the same speed
B. Stone B D. None of the above

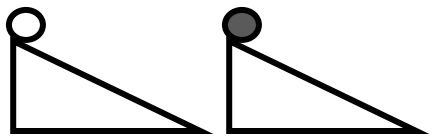
60. Objects in a circular motion maintain their circular path because of

A. tangential speed C. centrifugal force
B. centripetal force D. the pull of gravity

61. What is the torque at the bottom if the radius is 3 meters and the applied force is 4 N?

A. 6 N-m B. 8 N-m C. 9 N-m D. 12 N-m

62. A ring and a coin of the same mass and radius were allowed to roll down an inclined plane. Which will reach the bottom first?



A. The coin C. They will hit at the same time
B. The ring D. None of the above

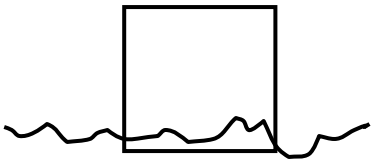
63. In the problem above, which will have the higher velocity at the bottom?

A. The coin C. They will have the same speed
B. The ring D. None of the above

64. In uniform circular motion, all the statements are correct EXCEPT

A. speed is constant
B. direction of the motion is continually and uniformly changing
C. acceleration is constant in magnitude and is directed towards the center
D. centripetal force remains constant all through out the motion

65. A Styrofoam block is seen floating in a pool. The block is partially submerged because its density is



A. greater than the density of water
B. equal to the density of water
C. less than half that of water
D. more than half the density of water

66. Two containers have the same volume; one is filled with sand while the other is filled with feathers. When the two containers are fully submerged in water, the buoyant force is greater on the one filled with

A. sand
B. feathers
C. the same as long as the volume does not change
D. data is not sufficient

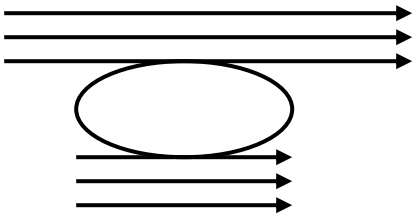
67. But when the container filled with sand was allowed to sink while the container with the feathers was allowed to float, which of the two have the higher buoyant force?

A. sand
B. feathers
C. the same as long as the volume does not change
D. data is not sufficient

68. Liquid pressure in a confined container is dependent on

A. density of the liquid only
B. depth of the liquid
C. depth and density of the liquid
D. volume of the liquid

69. When air travels at a higher velocity on one side of an object as compared to another side, what would happen to the object?



A. It will move toward the faster air
B. It will move toward the slower air
C. It will be blown away
D. It will not move

70. Why are dams constructed such as the bottom is thicker than the top?

A. Water pressure is higher at the top
B. The thicker bottom is the dam's foundation
C. Air pressure affects the top of the dam compressing it downward
D. Water pressure is greatest at the bottom

71. What is the density of 3 liters of water?

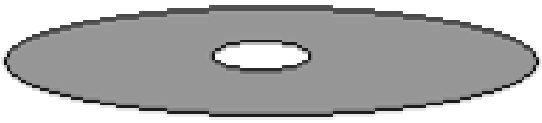
A. 1 kg/L B. 2 kg/L C. 3 kg/L D. 4 kg/L

72. Which of the following is true?

A. atmospheric pressure is constant at 77 mmHg
B. the air pressure in a confined container is higher at the bottom of the container
C. air pressure acts perpendicular to the surface of an object
D. increasing the air pressure would cool down an area.

73. A metal plate with a hole at the center is heated until the metal begins to expand, what will happen to the hole?

A. It will be bigger
B. It will be smaller
C. It will remain the same
D. It will increase then decrease



74. A student pumping up a bike tire notices that as they pump with vigor that the bicycle valve and pump itself appears to be warm. Why is this so?

A. Because of friction of the pump
B. The work being done in compressing also heats the air
C. Many air molecules collide because of increased pressure
D. None of the above

75. An ideal gas is heated in a closed container at constant volume. Which of the following properties of the gas increases as the gas is heated?

A. The atomic mass of the atoms in the molecules
B. The number of molecules
C. The density of the gas
D. The pressure exerted by the molecules on the walls of the container

76. Which of the following is an example of convection?

A. The heat of the sun warming our planet
B. An overhead fan cooling a room
C. The heat from an electric stove warming a frying pan
D. Ice cubes cooling down a glass of water

77. If you place equal size open containers of hot water and cold water in a freezer, the hot water will freeze before the cold water container. Is this true?

A. No it is not true.
B. the two containers freeze at the same time
C. Yes the hot water can freeze before the cold water due to evaporation effects
D. Yes because hot water cools down faster

78. Evaporating water vapor actually

A. warms the surrounding area
B. cools the surrounding area
C. cools then it will warms the surrounding area
D. have no effect on the temperature

79. An air-conditioning machine cools a room by

A. Adding cold air into the room
B. Removing warm air form the room
C. Adding cold to the room
D. Removing heat from the room

80. Convert 100 °C into °F.

A. 87.5 B. 122.4 C. 212 D. 314

81. When an object absorbs heat the following is TRUE EXCEPT

A. the object will always increase its temperature
B. the object may contract
C. the object may increase in length
D. the object may change it phase

82. It is the amount of heat needed by 1 gram of water to increase its temperature by 1°C?

A. 1 joule B. 1 calorie C. 1 ounce D. 1 thermal

83. When a long-haired woman puts her hands on a Van de Graaff generator her hair stands on end. Which of the following explains this phenomenon?

A. Like charges attract
B. Like charges repel
C. a magnetic field that draws her hair up on end
D. Her body is conducting a current to the ground

84. Two charged particles exert a force of magnitude F on one another. If the distance between them is doubled and the charge of one of the particles is doubled, what is the new force acting between them?

A. two times as much
B. half as much
C. one fourth as much
D. the same

85. How does a compass work?

A. The north end of the compass needle points to the north pole
B. The south end of the compass needle points to the north pole
C. The compass needle aligns perpendicular to the poles
D. Not enough information

86. When a voltage in light bulb is doubled the current will

A. double B. quadruple C. be halved D. have no effect on the current

87. As more lamps are connected to a series circuit, the over-all current in the power source

A. increases
B. decreases
C. remains the same
D. not enough information

88. As more lamps are connected to a parallel circuit, the over-all current in the power source

A. increases
B. decreases
C. remains the same
D. not enough information

89. Heat a copper wire and its electric resistance

A. increases
B. remains the same
C. decreases
D. none of the above

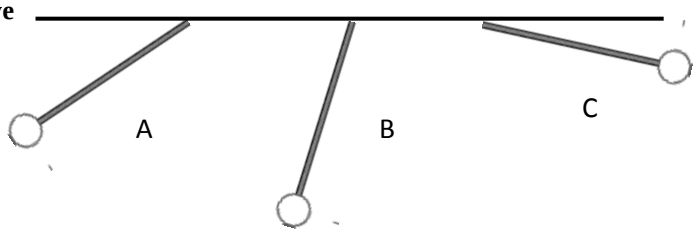
90. Stretch a copper wire twice its length and the resistance between its ends

A. increases
B. remains the same
C. decreases
D. none of the above

91. What should a piano tuner do to correct the sound of a string that is flat, that is, it plays at a lower pitch than it should?

A. Tighten the string to make the fundamental frequency higher
B. Tighten the string to make the fundamental frequency lower
C. Loosen the string to make the fundamental frequency higher
D. Loosen the string to make the fundamental frequency lower

92. Pendulum A, Pendulum B and Pendulum C have the same length. If they are released from their initial positions, which pendulum will reach its lowest point first?



A. Pendulum A
B. Pendulum B
C. Pendulum C
D. None of the above

93. Which pendulum will have the higher velocity at the bottom?

A. Pendulum A
B. Pendulum B
C. Pendulum C
D. It would depend on the mass of the pendulum

94. A concave lens will show you a

A. smaller image B. larger image C. mirror image D. opposite image

95. A convex mirror will show you a

A. smaller image B. larger image C. mirror image D. opposite image

96. Which of the following has the shortest wavelength?

A. red B. blue C. yellow D. orange

97. Ernie wants to catch a fish by using a spear, in order to increase his chances of hitting the fish, he should:

A. aim above the fish
B. aim directly at the fish
C. aim below the fish
D. use a fishing rod

98. Energy of a wave is often associated with its wavelength. The higher the energy

A. the longer the wavelength
B. the shorter the wavelength
C. the longer the wavelength then becomes shorter
D. not affected by the wavelength

99. Doppler effect is observed when the frequency of an approaching sound

A. increases
B. decreases
C. remains the same
D. all of these

100. A tuning fork is used to tune of a piano, this is done by tapping the tuning fork and adjusting the correct string until it vibrates with the tuning fork. The principle used here is?

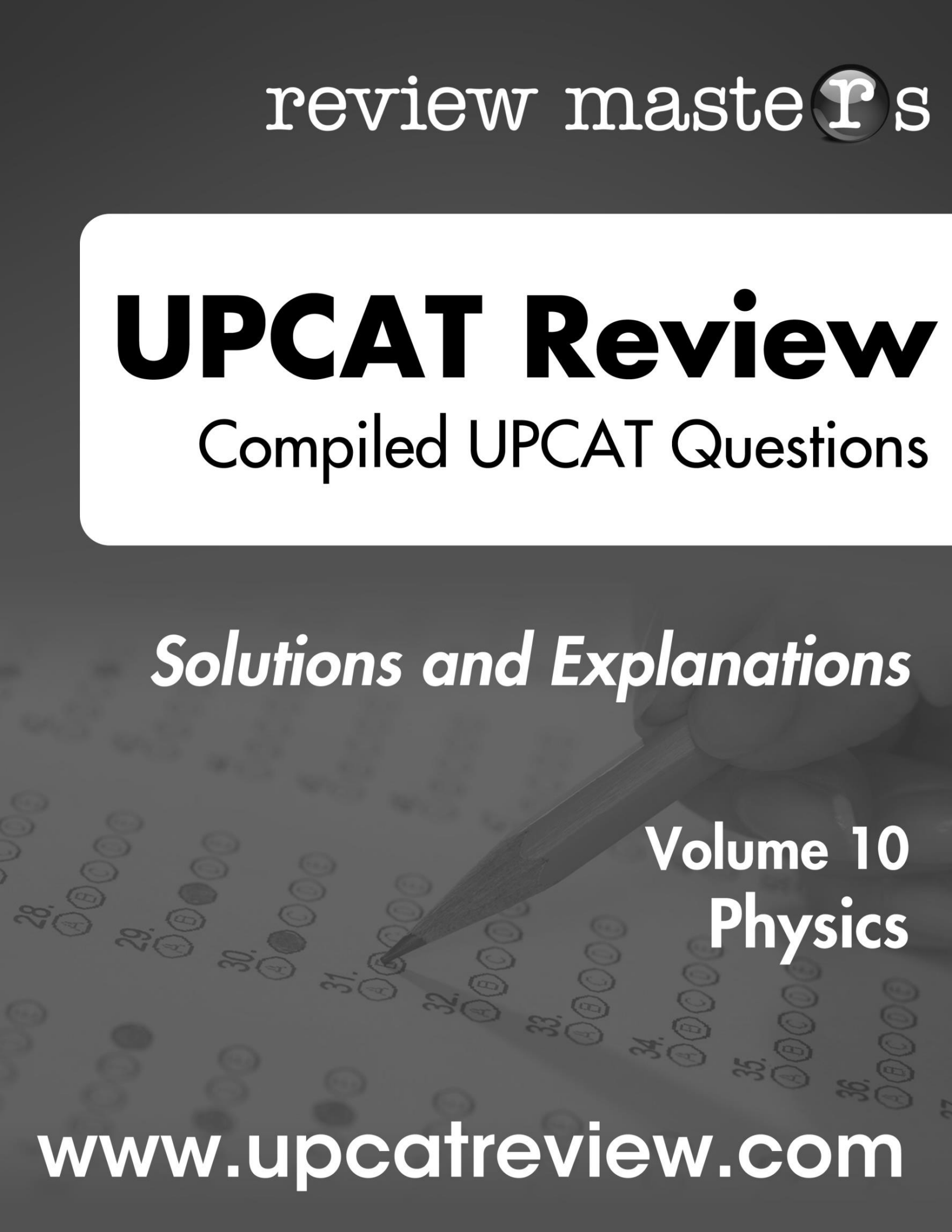
A. forced vibration
B. Doppler effect
C. Resonance
D. Interference

review masters

UPCAT Review

Compiled UPCAT Questions

Solutions and Explanations



Volume 10
Physics

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PHYSICS REVIEW TEST - ANSWER KEY

1. **D**

The metric system is the world standard for measurement. Not only is it used by scientists throughout the world, but most nations have adopted it as their standard of measurement.

Meters, grams, and liters form the basis for larger or smaller units. The units are named using these prefixes:

Kilo = 1000
Deci = 1/10
Centi = 1/100
Milli = 1/1,000
Micro = 1/1,000,000
Nano = 1/1,000,000,000

The table below shows how meters are related to five other measures of length.

Unit	Length
kilometer (km)	1,000 m (1×10^{3} m)
meter (m)	1 m
centimeter (cm)	0.01 m (1×10^{-2} m)
millimeter (mm)	0.001 m (1×10^{-3} m)
micrometer (um)	0.000001 m (1×10^{-6} m)
nanometer (nm)	0.000000001 m (1×10^{-9} m)

Thus, 1 mm = $(1 \times 10^{-3}) \div (1 \times 10^{-9}) = 1 \times 10^{6}$ nm or **1,000,000 nm**

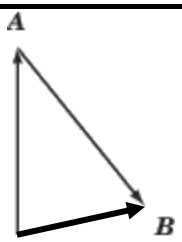
2. **D**

Giga = 1,000,000,000 Kilo = 1,000

Thus, 1 GW = 1,000,000,000 ÷ 1,000 = **1,000,000 kW**

3. **A**

The magnitude and direction of the sum of two or more vectors can be determined by use of an accurately drawn scaled vector diagram. Using a scaled diagram, the **head-to-tail method** is employed to determine the vector sum or resultant.



4. **D**

A = -5, B = +2. Thus, 2A – B = 2(-5) – (+2) = -10 – 2 = **-12 or 12 in the leftward direction**.

5. **B**

A **scalar quantity** has only *magnitude*. A **vector quantity** has both *magnitude and direction*.

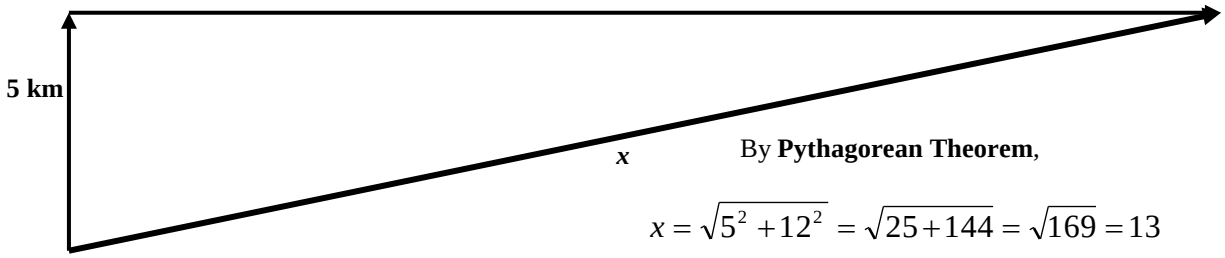
Scalar Quantities	Vector Quantities
length, area, volume,	*displacement*, direction,
speed	velocity
mass, density,	*acceleration*
pressure	momentum
temperature	*force*
energy, entropy	lift, drag, thrust
work, power	weight

6. **B**

See Item # 5 explanation.

7. **C**

6 km/hr x 2 hrs = **12 km**



By **Pythagorean Theorem**,

$$x = \sqrt{5^2 + 12^2} = \sqrt{25 + 144} = \sqrt{169} = 13$$

8. **C**

Displacement refers to an object's change in position. It's the vector that points from the object's initial position to its final position, *regardless of the path actually taken*.

The athlete runs exactly four times around an oval track, a total distance of **400 m x 4 = 1600 m**. But since he goes back to his original position, his *total displacement* is **0 m**.

9. **D**

For **maximum velocity**, the wind should be in the *same direction* as the runner.

10. **B**

In the **parallelogram method** for vector addition, the vectors are moved to a common origin and the parallelogram constructed as follows:

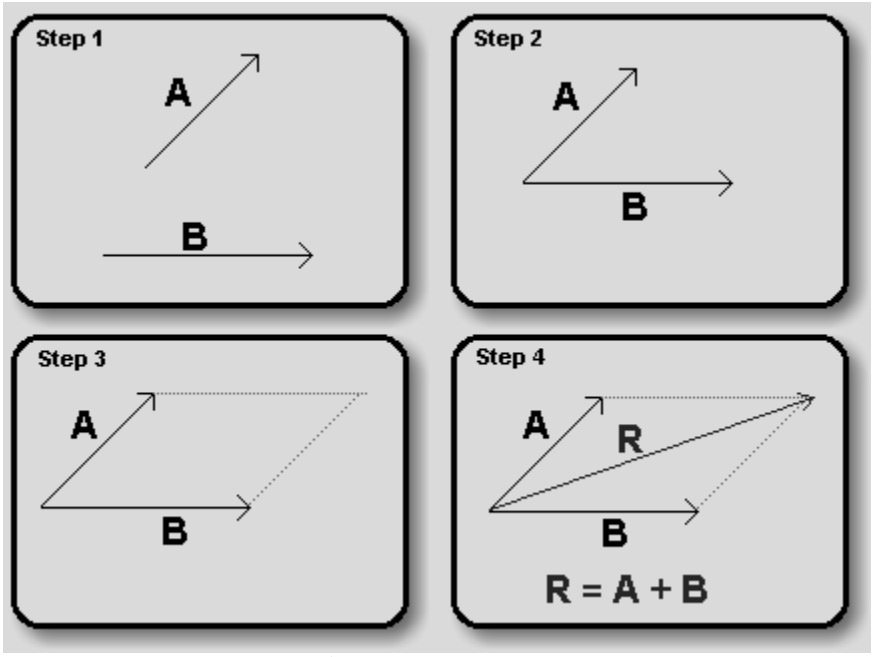


Image from http://www.physchem.co.za

The ***resultant R*** is the *diagonal* of the parallelogram drawn from the common origin.

11. **B** For **minimum resultant**, the vectors must be in *opposite directions*.

12. **B** **Operations that are *Not* Legal for Vectors**

There are certain operations that are ***not legal*** (and not meaningful) for vectors:

- *A vector cannot be set equal to a scalar.*
- ***A vector cannot be added to or subtracted from a scalar.***
- *A vector cannot occur in the denominator of an expression*. (Although you can't divide by a vector, note that you can legally divide by the magnitude of a vector, which is a scalar.)

13. **C** An **object in motion** has *speed*, *direction*, and *velocity*.

14. **C** **A bus traveling at a constant velocity** – to have acceleration the object must either *increase velocity* (A), *decrease velocity* (B), or *change direction* (D). Having a ***constant velocity*** means that there is no acceleration.

15. **B** The velocity will increase at a rate of 10m/s every second it falls – whatever the situation presented, the acceleration due to gravity is always $10 m/s^2$ or more precisely $9.81 m/s^2$.

16. **B** *When shooting arrows using a bow, how do we aim for the target?*

Aim higher. The arrow moves mainly horizontally, but gradually also acquiring a downward fall. So if the monkey does not drop off the branch, the arrow might miss the monkey, passing below the monkey. But since the monkey drops off the branch, **the arrow hits the monkey** right on target!

17. **C** **They will hit at the same time** – in falling objects, only the vertical motion is considered when you want to know the time for an object to fall. Since the bullet was fired horizontally *without any vertical force*, it would act as if it was dropped like its shell. Therefore, they will hit at the same time.

18. **B** ***Average speed*** is not a vector quantity. It has *no direction*.

The simplest way to find average speed is to divide the total distance travelled by the total time taken.

Thus, in the problem, **average speed = 100m/10s = 10 m/s**

19. **C** **acceleration = *(final velocity – initial velocity)/time = (31 m/s – 3 m/s)/4 s* = $7\ m/s^2$.**

20. **C** The ***maximum linear distance*** is achieved by an angle of **45 degrees**.

21. **C**

A **projectile** is an object upon which the *only force acting is gravity*. There are a variety of examples of projectiles. An object **dropped from rest** is a projectile (*provided that the influence of air resistance is negligible*). An object which is **thrown vertically upward** is also a projectile (*provided that the influence of air resistance is negligible*). And an object is which **thrown upward at an angle to the horizontal** is also a projectile (*provided that the influence of air resistance is negligible*). A projectile is any object which once projected or dropped continues in motion by its own inertia and is influenced only by the *downward force of gravity*.

22. **A**

The plates on the table in the magic trick all have inertia. Pulling the tablecloth is an outside force acting on the plates. If the outside force acts quickly enough, the inertia of the plates keeps them from moving. In order for the trick to be successful, the tablecloth has to be yanked out very quickly while the inertia of the plates on top of the table keeps them in place. In addition, the "slippery" tablecloth lessens the force. Imagine if the magician used sand paper instead of a tablecloth; he or she then wouldn't be able to pull it out fast enough to avoid causing the plates on the table to move.

23. **C**

As the skydiver falls, he picks up speed. The increase in speed leads to an increase in the amount of **air resistance**. Eventually, **the force of air resistance becomes large enough to balance with the force of gravity**. At this instant in time, the net force is *0 Newtons* so the the object will *stop accelerating*. The object is said to have "**reached a terminal velocity**."

24. **B**

In a **state of equilibrium**, where the object is at rest or proceeding at a constant velocity, the net force in every direction must be equal to 0.

At a constant velocity (including zero velocity), the sum of forces is 0. *If the sum of forces does not equal zero, the object will accelerate* (change velocity over time).

25. **C**

The **more mass** an object has, the ***more inertia*** it has. **Inertia** is the property of a body that it resists a change in motion. If it's moving, it wants to keep going. If it's sitting still, it doesn't want to move. Inertia is resistance to any change in velocity. And the larger a mass is, the more resistant it is to a change in velocity. *There is a direct correlation between the mass of an object and its inertia*.

26. **C**

For any force to have an affect on the vertical velocity, the force must have at least a component in the vertical direction. The direction *of the force in **choice letter C** is horizontal*. It has zero effect on motion in the vertical direction.

27. **B**

If there is no friction, the speed will be the same. But since there is friction, energy lost to the work done by the friction, so the kinetic energy is less so as the speed is less too. Thus**, it takes more time to slide down the incline plane than it took to slide up**.

28. **B**

The frictional force is **equal** to the applied force (*pull*) until the object begins moving.

29. **B**

The scale will give **a reading greater than 70kg** – the weighing scale would give a *lower reading in an elevator that is going down* and a *higher reading when the elevator is going up*.

30. **A**

Static friction is the force that acts against any applied force trying to put the object in motion.
Kinetic friction resists the motion of a moving object.

It is obvious that *it is harder to get something to start moving than it is to keep it moving*. This is because **the static friction is greater than kinetic friction.**

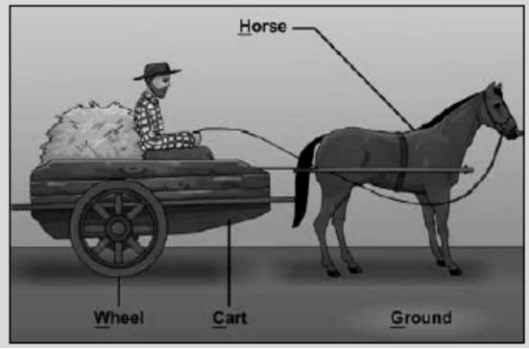
31. **C**

Both the same – when two forces are acting on the same object in the opposite direction, the forces would be the same because of the ***law of action-reaction***.

32. **C**

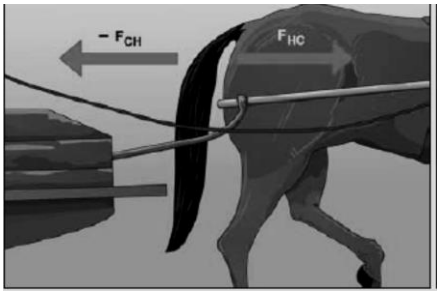
Weight = Mass x Acceleration due to gravity = (80 kg)(9.8 m/s^2) = **784 N**

33. **D**



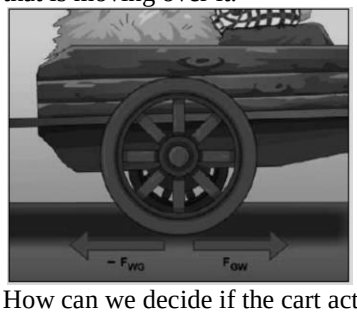
There are many forces acting on a horse and cart, including friction between wheels and axle, etc. But we will concentrate on just **three action-reaction pairs** (*A-R pairs*), as shown in the diagram. Imagine that the cart is accelerating. This means that there must be a resultant force in the direction of the acceleration (*because the force is the cause and the acceleration is the effect*).

The *first A-R pair* is the *pull of the horse on the cart and the equal and opposite pull the harness exerts on the horse*.

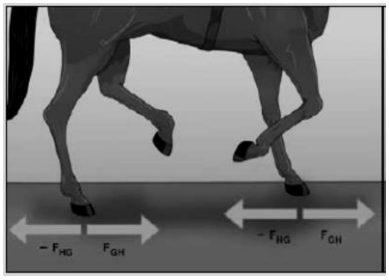


These can be considered "*internal forces*" and won't affect the acceleration. You wouldn't try to push a car stuck in the mud by sitting in the front seat and pushing on the dashboard!

If we examine the force between *the wheel and the ground*, we see the action of the wheel as it tries to move in a forward direction and the reaction of the ground on the wheel. This force of reaction is what we would call "*resistance*" or the *frictional force* that the surface (*the ground*) exerts on the body (*the cart*) that is moving over it.



Finally, we look at the force that we are fairly certain causes the cart to move forward. BUT LET'S BE CAREFUL HERE AS THERE IS A LITTLE TRAP FOR YOU UNLESS YOU ARE WIDE AWAKE! If the horse's hoof pushes backwards on the ground, there is a reaction from the ground that pushes forwards. The cart accelerates forwards, so which of those two forces causes the acceleration? *The answer is that* **the force of the ground on the horse's hoof is what propels the cart forward!!**



How can we decide if the cart actually accelerates forwards? We must find the resultant of all the forces that can either propel the cart forward or resist attempts to do so. If the magnitude of F_{GH} is greater than the magnitude of the oppositely directed resistance (F_{GW}) then the cart will accelerate forwards. ***And it is the force of the ground on the horse that is mainly responsible!***

34. **C** **A snail climbing a wall** – momentum is given by the equation **q = mv**, where **q = momentum**, **m = mass** and **v = velocity**. In the question, **only C has momentum** *because the rest has zero velocity*.

35. **D** **Increasing the volume of the object while maintaining its mass and speed** – only the *mass and speed* of an object determines its *momentum* and ***not*** *the volume*.

36. **B** **The airplane is a projectile acted upon by gravity alone** – if *the airplane is in equilibrium* (**D**) then *there is no net force acting upon it* (**C**), therefore the *momentum will be constant* (**A**). **Letter B** is the correct answer since the question states that the airplane is moving in a *straight path*. A projectile moves in a parabolic path.

37. **A** $\mathbf{m_1v_1 = m_2v_2}$, where $m_1 = m$, $v_1 = v$, $m_2 = m + M$, $v_2 = v'$. Thus, $\mathbf{v_2 = m_1v_1/m_2}$ or **$\mathbf{v' = mv/(m + M)}$**

38. **B** ***Air bags*** are designed **to increase the time interval** during which the driver's momentum decreases during a head-on collision, *reducing the net force on the driver*.

39. **A** **2 times greater** – in reverse, *the faster it takes for the impact force to occur, the greater the impact force*.

40. **C** **Impulse** is defined as the *change in momentum*. *Whether the surface is hard or soft*, the **change in momentum would be the same**. However, the shorter time you stop, the higher the impact force that you will experience thus hurting yourself more.

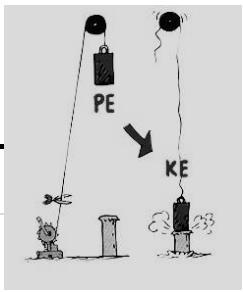
41. **C** **Both the truck and the bicycle experienced the same change in momentum** – this is due to ***action reaction*** and the ***law of conservation of momentum***, *when two objects collide they change in momentum is always equal*.

42. **D** Newton's law says, "***for every action there is an equal and opposite reaction***" meaning that if the bullet had enough force to knockdown your target, firing a heavy bullet would have more force to knock you down. *It is extremely dangerous (and fatal) for the sniper to fire a bullet heavier than the gun*.

43. **A** The center of mass velocity of a system of particles is the average velocity of all the particles weighted relative to their mass. Thus, $v_{cm} = \frac{m_1v_1 + m_2v2}{m} = \frac{(1)(10) + (1)(-20)}{2}$ = *-5 m/s or* **5 m/s to the left**

44. **D** **They will hit at the same time** – the law of conservation of energy would come to play here. The total kinetic energy at the bottom must be equal to the total potential energy at the top whatever path the ball takes.

45. **C** *When an object falls to the ground*, its potential energy is **changed into kinetic energy**. Initially, it contains only potential energy, PE. As it falls, this stored energy is converted into kinetic energy, KE.



46. **A** KE = PE $\rightarrow$ ½ $mv^2 = mgh \rightarrow$ ½ $v^2 = gh \rightarrow v^2 = 2gh \rightarrow$ $v = \sqrt{2gh} = \sqrt{2(10\frac{m}{s^2})(5m)} = \sqrt{100\frac{m^2}{s^2}} = 10\frac{m}{s}$

47. **D** *Work = Force x Distance = (75 N)(3 m) =* **225 N-m**

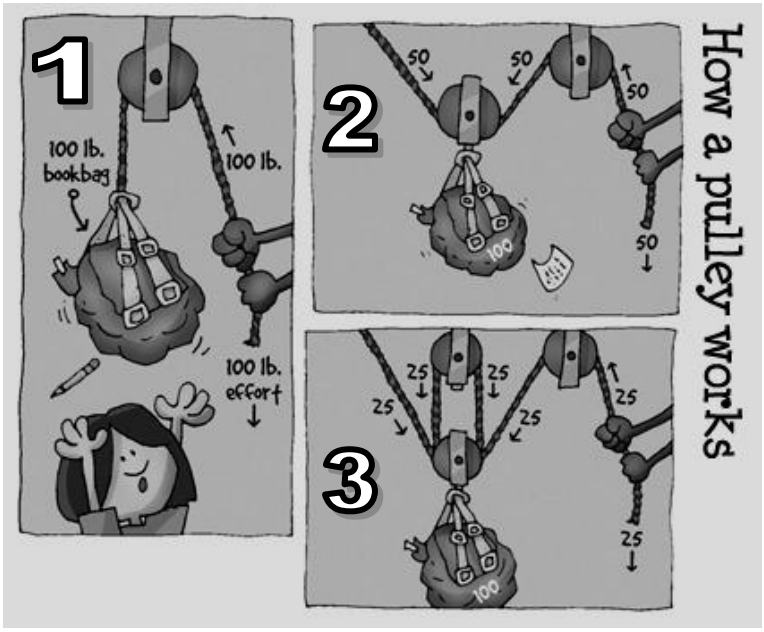
48. **C** *Work = Force x Distance = (20 N)(8 m) =* **160 J**

49. **B** *Power = Work/Time* $\rightarrow$ *P = W/t* $\rightarrow$ *if Work is doubled and Time remains the same,* $P_{new} = 2W/t =$ **2P**

50. **A** **KE = ½ mv^2** , *If v is doubled,* $KE_{new} = ½\ m(2v)^2 = ½\ (4mv^2) = 4(½\ mv^2) =$ **4KE**

51. **C** **Types of Pulleys**

Image from http://dogfoose.files.wordpress.com



1. A **fixed pulley** has a fixed axle and is used to redirect the force in a rope (called a belt when it goes in a full circle). A *fixed pulley* has a ***mechanical advantage of 1***.
2. A **movable pulley** has a free axle, and is used to transform forces - when stationary the total force on the axle balances the total force provided by the tension in the rope (which is constant in magnitude in each segment). If one end of a rope is attached to a fixed object, pulling on the other end will apply a doubled force to any object attached to the axle. A *movable pulley* has a ***mechanical advantage of 2***.
3. A **compound pulley** is a system of movable pulleys. The *mechanical advantage can be increased by using a* ***block and tackle***, where there are several pulleys on each axle.

52. **B** It is important to notice that a system of pulleys *does not change the amount of work done*. The work is given by the force times the distance moved. The pulley simply allows trading force for distance: you pull with less force, but over a longer distance.

Work = Force x Distance = Mass x Acceleration due to Gravity x Distance = (10 kg)(10 m/s^2)(1 m) = **100 J**.

53. **C** *Work = Force x Distance* $\rightarrow$ *W = Fd* $\rightarrow$ *if Force is doubled and Distance is also doubled,* $W_{new} = (2F)(2d) = 4Fd =$ **4W**

54. **B** *Weight = Mass x Acceleration die to Gravity* $\rightarrow F_w = mg = (40\ kg)(9.8\ m/s^2) =$ **392 N**

55. **A** Increasing the density of the Earth would increase the force of gravity on you and "*the force of gravity on you*" is *your weight*. That is, *your weight would increase*. Actually, Earth does not have uniform density. The center of Earth is more dense than Earth's crust or outer layers. Therefore, as you go down in a deep mine, your weight actually increases!

56. **D** The force of gravity is an ***inverse-square force***. Earth's surface is one Earth radius away from Earth's center. So if the Earth's radius is halved, the force of gravity -- and the acceleration due to gravity -- will be $(2)^2$ as great as the original g. Thus, $\mathbf{g_{new} = 4g}$.

57. **C** The force of gravity between two objects is ***always equal and opposite*** given by the equation $\mathbf{F_g = GM_1M_2/d^2}$, where **G** is the *gravitational constant*, $\mathbf{M_1M_2}$ are the *masses* and **d** is the *distance between them*.

58. **C** Friction is not always reliable at circular turns if high speeds and sharp turns are involved. To avoid dependence on friction, the roads are banked at the turn so that the outer part of the road is somewhat lifted up as compared to the inner part.

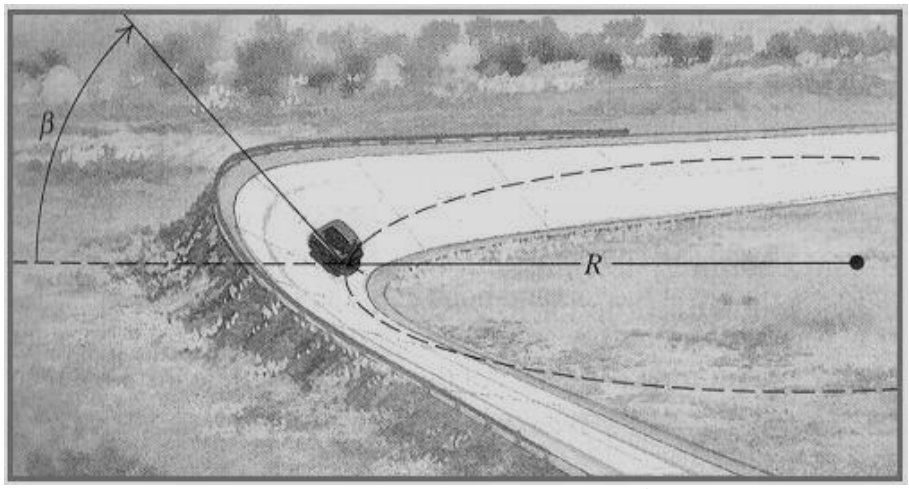


Image from http://www.tutorvista.com

Riding a car around a curve, we are at rest in the car, and should be undisturbed in our seats. Nonetheless, we feel sideways force applied to us from the seats and doors and a need to lean to one side. To explain the situation, **a centrifugal force is acting upon us and must be countered**. We find this discomfort is *reduced* ***when the curve is banked***, tipping the car inward toward the center of the curve.

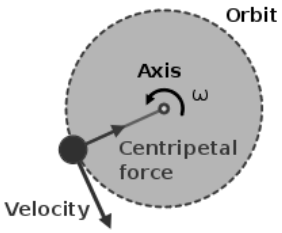
59. **B** The velocity of the orbiting body does not increase linearly; the relationship is such that the **velocity increases inversely as the square root of the orbital radius**:

$$v = \sqrt{\frac{GM}{r}}$$

where G is the gravitational constant, and M is the central mass.

The important principle here is that **as the radius of the orbiting body becomes shorter, its velocity increases**.

60. **B** An object in circular motion always tries to move in a straight line (***Law of Inertia***). However, there is a force that acts toward the center of the motion. This force is called the **centripetal force**. It is the *centripetal force* that *makes an object travel in a circular path*.



61. **D** *Torque = Force x Radius = (4 N)(3 m) =* **12 N-m**

62. **A** When rolling down an incline the object with the smallest moment of inertia will get to the bottom first. **The coin will reach the bottom first** because it has a *lower moment of inertia* as compared to the ring. Lower moment of inertia means *less friction*. Remember, in this situation, spheres always beat disks (*represented by the coin*) which always beat rings.

63. **C** **They will have the same velocity** – *the law of conservation of energy* would come to play here. The total kinetic energy at the bottom must be equal to the total potential energy at the top whatever path the ball takes.

64. **C** *Centripetal force changes direction*.

65. **C** When an object floats in water, then its density is less than that of water. The density relative to the water can be determined by measuring the percentage of the volume submerged. In this case the object is *less than half submerged*, therefore the **density is less than half of water**.

66. **C** *The buoyant force is dependent on the **volume** of the submerged object.* Since the two containers have the same volume, the **buoyant force is the same** on both containers. The fluid surrounding the bag of sand is behaving the same way as the fluid surrounding the bag of air. For equal volumes, the buoyant force acting on the bag of sand is the same as the buoyant force acting on the bag of air. This is true for submerged objects of any shape, size or density.

67. **A** **Archimedes' Principle** states that *an immersed body is buoyed up by a force equal to the weight of the fluid it displaces, not the weight of the object itself*.

68. **C** Pressure is given by the equation $p = \rho gh$ where ρ = ***density***, g = ***gravity*** and h = ***depth***

69. **A** *When air travels at a higher velocity on one side of an object as compared to another side*, **the object will move toward the faster air.**

70. **D** ***The water pressure at the bottom is much more than at the top***. In greater depths, there is more water "piled up," which causes the pressure to be greater at the bottom than at the surface. A dam's design must enable it to withstand greater pressure *at the bottom than at the top*.

71. **A**

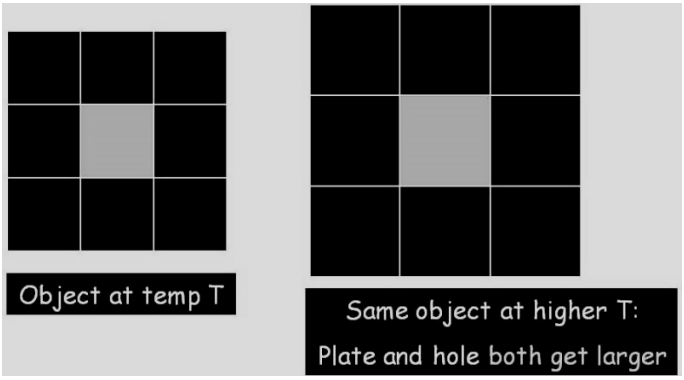
Although the density of water varies somewhat with temperature and pressure, and is higher for salt water than fresh water, you can use **1 kilogram (1000 grams) per liter** for water's mass density.

72. **C**

- *A is false*. The *standard atmospheric pressure* is measured in various units: 1 atmosphere = **760 mmHg** = 29.92 inHg = 14.7 lb/in2 = 101.3 KPa
- *B is false.* In *a confined container*—neglecting the effect of gravity on the gas—**the pressure is the same throughout the container**, pressing equally on all the walls.
- *D is false.* An area of high pressure is usually associated with hot clear summer days. In a high pressure, the air is generally slowly sinking, or 'subsiding'. As air falls **it warms**.
- **C is true**. ***Air pressure acts perpendicular to the surface of an object***.

73. **A**

Most materials when heated will expand (water being one exception when its temperature is close to 0^oC). If various metals are heated in a Bunsen flame then they will expand. Conversely if they are cooled they will contract. If a metal plate containing a hole is heated then the whole plate will expand including the hole. Students usually believe that when the metal surrounding a hole is heated then the hole will get small when it actually should increase in size.



Why does the hole get bigger when the plate expands?

Imagine a plate made from 9 smaller pieces (*see figure above*). Each piece expands. If you remove one piece, it will leave an "expanded hole"

74. **B**

Whenever the pressure exerted upon a gas is increased, the volume of the gas is decreased; and that whenever the pressure upon a gas is decreased, the volume of the gas is increased. If the pressure is changed very slowly, the change in the temperature of the gas is imperceptible; if, however, the pressure is removed suddenly, the temperature falls rapidly, or ***if the pressure is applied suddenly, the temperature rises rapidly***. **When bicycle tires are being inflated, the bicycle valve and pump becomes hot *because of the compression of the air***.

75. **D**

Because we are dealing with a closed container, we know the volume remains constant. Because pressure and temperature are directly proportional, we know that if the ideal gas is heated, its *temperature is increased*, and then the **pressure exerted by the molecules on the walls of the container is increased** as well. This is why it's a really bad idea to heat an aerosol canister.

76. **D**

Convection is the *transfer of heat from a region of higher temperature to a region of lower temperature* by the displacement of high-energy molecules. For example, an ice cube in a glass of water eventually melts. This is because the heat from the water, which is warmer, flows to the ice cube until both are at the same temperature, and therefore no ice cube is left. **The ice cubes cooling down a glass of water is actually the water warming the ice cubes**.

77. **C** Scientists have known for generations that hot water can sometimes freeze faster than cold, an effect known as the **Mpemba effect**. Theories for the Mpemba effect have included ***faster evaporation of hot water***, which reduces the volume left to freeze.

78. **B** **Water vapor actually cools the surrounding area** by evaporation of water on ground level, water droplets in atmosphere and by cloud formation.

79. **D** An air conditioner seems to cool your home's air, but it actually makes your home cooler by **removing heat from the indoor air** and *transferring that heat outdoors*. Heat is extracted from the home by passing indoor air across a refrigerant coil in the indoor unit. Refrigerant lines then carry the heat to the outdoor unit, where it is released into the outside air. The cooling cycle continues until the indoor temperature reaches the thermostat setting.

80. **C** $°F = 1.8°C + 32 = 1.8(100) + 32 = 180 + 32 =$ **212°F**

81. **A** There are situations where the *addition of heat* ***does not cause a change in temperature***. Instead something a little different happens. You are familiar with this if you ever had a glass of water with ice. The ice water is at a temperature close to 0 degrees Celsius. *As heat is added* to the system, the *ice begins to melt* but the *temperature of the water does not increase*.

82. **B** **One calorie -** *the quantity of heat required to raise the temperature of 1 gram of water by 1°C from a standard initial temperature.*

83. **B** Charge (*either positive or negative*) is brought to the woman by the Van de Graaf generator. This charge then migrates to the ends of her hair. The **repulsive force between like *charges*** *makes the hair separate and stand on end*.

84. **B** ***Coulomb's Law*** tells us *that the force between two particles is directly proportional to their charges and inversely proportional to the square of the distance between them*. If **the charge** of one of the particles is **doubled**, then the **force is doubled**. If the **distance between them is doubled**, then the **force is divided by four**. Since the force is multiplied by two and divided by four, the net effect is that the force is **halved**.

85. **B** A magnetic compass consists of a small, lightweight magnet balanced on a nearly frictionless pivot point. The magnet is generally called a needle. One end of the needle is often marked "N," for north, or colored in some way to indicate that it points toward north**. The south end of the compass (magnetized) points toward the North Magnetic Pole**. The opposite end points south.

86. **A** The ***current*** is given by the equation **I = V/R** (*ohm's law*), where *I = current, V = voltage and R = resistance.* The resistance of equipment doesn't change even if either current or voltage is increased. Therefore, *when you double the voltag*e in a light bulb, then the ***current would also double***.

87. **B** *As more lamps are connected to a series circuit, the over-all current in the power source* **decreases.**

88. **A** *As more lamps are connected to a parallel circuit, the over-all current in the power source* **increases**.

89. **A** The *resistance of metals* **increases** *as temperature is raised*. This is the reason why computers are usually kept in an air-conditioned room.

90. **A** **Resistance** is given by the formula **R = ρL/A**. So if you *double the length*, the *resistance is also doubled* (**increases**).

91. **A** The easiest way to solve this problem is through simple intuition. When you tighten a string, it plays at a higher pitch, and when you loosen a string, it plays at a lower pitch. Pitch and frequency are the same thing, so in order to raise the pitch of the piano string, **the tuner has to tighten the string, thereby raising its fundamental frequency**.

92. **D** A ***pendulum*** is any object that is suspended from a fixed point so that it swings freely back and forth under the action of gravity. The ***period*** of a pendulum is the time it takes to swing out and back to its *point of release*. One of these "out and back" swings is a *cycle*. The **period of the pendulum depends on the length**, and *not on the mass or starting position*. Since the three pendulums have equal length, they all have the same **period**, meaning, they will **reach the lowest point all at the same time**. Remember, ***changing the starting position does not change the period***.

93. **C** As pointed above, the starting position does not change the period. This means that if you release the pendulum at a higher position, you will increase the force towards the center and hence the acceleration (a condition for *simple harmonic motion*). You can see that the extra distance travelled is exactly offset by the ***increase in velocity***. So **the higher the starting position is, the greater is the velocity at the bottom**.

94. **A** A ***concave lens*** spreads light rays apart and it makes objects at any distance seem **smaller** than normal.

95. **A** A ***convex mirror*** works the same way as a ***concave lens*** does. Thus, it will **show you a smaller image**.

96. **B**

Approximate wavelength For the various colors	
Color	**Wavelength (nm)**
Red	780 - 622
Orange	622 - 597
Yellow	597 - 577
Green	577 - 492
Blue	**492 - 455**
Violet	455 - 390

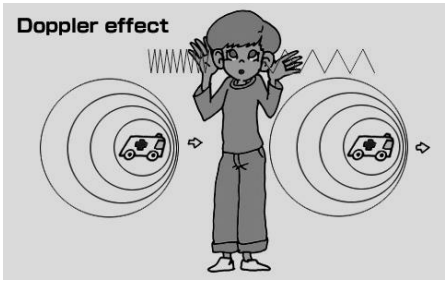
97. **C** Ernie who is spear fishing has to use some science to hit his underwater mark. Just as an aquarium bends light, so does the water in the pond. It's called ***refraction***. If Ernie aims right for a fish, the spear *will pass over its head*. He actually has to **aim below the image of the fish**, taking into account the angle of his line of sight, how deep the fish is, and so on.

98. B

Shorter wavelength means a higher frequency and thus higher energy. This is the reason why *UV light has very high energy*.

99. A

You have experienced the consequences of the Doppler effect if you have ever listened carefully to the *sound of a siren* or *high-pitched racecar engine* as it approaches and then recedes from you. You will have noted that the **pitch (frequency) of the sound increases as the source of the sound approaches** you and then *decreases as source moves away*.



100. C

Most objects have a natural frequency—a rate of vibration at which they tend to oscillate. For example, *the sound wave emitted by a tuning fork is the same each time it is struck*. Some objects have a set of natural frequencies; rather than producing sound waves at a single frequency, they create a more complex sound.

When two objects have the same natural frequency, the vibration of one of the objects can set the other object in motion as well. For example, if one tuning fork is struck, and a second tuning fork placed nearby has the same natural frequency, it will also start to vibrate. *The sound wave produced by the first tuning fork travels through the air and induces the second tuning fork to vibrate; this is an example of* **resonance**.